

XXXVII.—*On the Generic Identity of Climaxodus and Janassa, two Fossil Fishes related to the Rays.* By ALBANY HANCOCK, F.L.S., and THOMAS ATHEY.

[Plate XII.]

WHEN the paper on the teeth of *Climaxodus linguæformis* was published*, it was not thought desirable to hazard an opinion as to their arrangement, or whether they were palatal or mandibular, or whether or not they belonged to both the upper and lower jaws. Since then we have obtained information that throws much light on the subject of these curious dental organs.

Mr. Howse having called our attention to some well-preserved specimens of the teeth of *Janassa bituminosa* of Münster†, from the Marl-slate, it was at once obvious, as pointed out by that gentleman, that they were closely related to those of *Climaxodus*—so closely, indeed, that they seem to be generically the same. The differences are only those of proportion, there being not a single character of importance to distinguish one from the other.

The teeth in both forms are depressed and elongated in the antero-posterior direction, and taper a little backwards; in front there is a wide concave margin, which, standing up like a scoop or dredging-bucket, is the cutting-edge; behind this the surface is covered with transverse imbricated ridges, forming the grinding or crushing portion; and further down, on a lower plane, the broad depressed root projects backwards and downwards for a considerable distance. In profile they present a sigmoid curve, the frontal scoop-like portion standing up in the direction of the oral cavity, the posterior or root extremity being turned downwards in the opposite direction.

The above description will do equally well for either *Climaxodus* or *Janassa*. Our Coal-measure species, however, *C. linguæformis*, Atthey, is considerably wider in proportion to its length, and the transverse imbricated ridges are stronger and much less numerous than they are in *Janassa bituminosa*. But *C. imbricatus*, M'Coy, from the Mountain Limestone, seems somewhat intermediate between the two; it is proportionally narrower, and the ridges are much finer than in *C. linguæformis*.

From these teeth alone the generic identity of all the three might be safely predicated; but there is further evidence in proof of the fact. *Climaxodus* and *Janassa* are both provided with two kinds of teeth. Those already indicated may be

* Annals of Nat. Hist. ser. 4. vol. ii. p. 321.

† Beiträge zur Petrefactenkunde, Heft 2. p. 38, tab. 15. f. 10-14.

looked upon as the principal or primary dental organs; the other kind or the secondary, in the two genera, resemble each other just as closely as do the primary; and it is interesting to find that these secondary teeth agree pretty closely with some of those included in the genus *Petalodus* of authors, only they are oblique.

In *Janassa* the association of these Petalodontoid teeth with the primary ones is too obvious to be called in question. In this form the two kinds are actually found arranged in order side by side. This is proved by the specimens already referred to and by Münster's excellent figures. The Petalodontoid form has likewise been obtained associated on the same slab with the primary teeth of *Climaxodus*. We have in our possession a small slab, not so large as the palm of the hand, on which there are seven primary teeth, three or four of which lie in their natural position. On this slab there are likewise three of the *Petalodontoid* form, two being in contact with the primary teeth, and apparently not far removed from their original position.

Six or seven other specimens of these secondary teeth have occurred scattered in the same shale in which the primary teeth are found. The secondary teeth have a certain resemblance generically to the primary teeth, and specifically they have characters in common with their respective primary teeth. Nevertheless they are scarcely generically distinguishable from the *Petalodus* of authors, though they are, as already stated, oblique.

Having said thus much with respect to the external characters of the teeth themselves in the two genera in question, we must now make some remarks about their arrangement in the mouth. In *Janassa* it is clearly demonstrated, both by the specimens and figures before alluded to, that the teeth are similarly arranged in both the upper and under jaws. In this genus they are placed in slightly arched transverse rows, the largest symmetrical primary tooth being situated on the median antero-posterior line, and projecting a little in advance of the others. On each side of this there are two similar teeth, but somewhat less, the outside one being twisted obliquely; the row is then terminated on either side by one of the Petalodontoid form. There are therefore seven teeth in each row, including both kinds—five primary, two secondary. Münster represents five or six such rows in close succession from back to front, the teeth and rows gradually diminishing in size forward. It is evident, then, that the arrangement of the buccal armature more closely resembles that of the Rays than the Cestracionts or Sharks; and, indeed, notwithstanding the difference in the teeth themselves, in their arrangement they

agree in a remarkable manner with those in *Myliobatis aquila* and *Zygobatis marginata*—a relationship which was recognized by Agassiz*. In the extraordinary dental apparatus of these two interesting forms the teeth or plates are placed crosswise on the anterior portion of the jaws in rows succeeding each other from back to front. The largest primary tooth is median: on each side of it there are two other primary teeth, both of which are small in the first genus, and only one in the second; all these teeth are characterized by having six sides; and each row is flanked by a small or secondary tooth, distinguished by having only five sides. Thus it appears that each transverse row is composed of seven teeth, five of which may be looked upon as primary, two as secondary, arranged exactly as the teeth are in *Janassa*, and agreeing with them exactly in number.

Now it cannot be doubted that the disposition of the teeth is the same in *Climaxodus* as it is in *Janassa*; and in fact the specimens of the former, on the slab previously mentioned, verify this assertion when aided by the light derived from the latter. Alone perhaps these specimens might have justified the inference; but taken in connexion with what is known respecting *Janassa*, there can now be no hesitation upon the subject. Indeed the large, symmetrical, central teeth of two rows lie in proper order one over the other; and in contact with the upper one, and side by side with it, is the first lateral tooth in its exact true position; and a little further away, but almost touching it, is a secondary tooth, apparently belonging to this side. Overlying the first, lateral, primary tooth in front are the distorted remains of what seems to be the second lateral tooth. On the other side of the central tooth, and some little distance from it, is another primary tooth, which, from its oblique form, is undoubtedly the second lateral tooth of this side: it lies in juxtaposition to its flanking Petalodontoid tooth. All these teeth, with the exception of that last named, lie with their crowns uppermost, and belong to one row; the central tooth and the three lateral teeth of one side are all present, and lie nearly in their natural order; and the second lateral tooth and the secondary tooth of the other side are not far removed from their right position. So here we see a whole row of seven teeth complete, with the exception of one of the first lateral teeth. Two other small lateral teeth are on the same slab, and rest with their faces downwards, or in the opposite direction to those already spoken of. These belong apparently to the opposing jaw, and both lie in contact with the large central teeth; and one of them, as an opposing tooth,

* Poissons Fossiles, tome iii. p. 375.

occupies its correct position by the side of the upper central tooth. A third Petalodontoid tooth lies a little apart, and probably belongs to this jaw.

On another small slab recently obtained there is a fine specimen of a second lateral tooth associated with a secondary tooth.

From the above it appears that there is evidence enough to show that in *Climaxodus*, as in *Janassa*, the teeth are placed in transverse rows of seven teeth each, one being symmetrical and central, and six lateral, three on each side, the extreme lateral tooth on either side being Petalodontoid in form, that there are more rows than one, and that they are placed in both upper and under jaws. In fact it is quite evident, not only that the teeth in *Climaxodus* agree in external character with those in *Janassa*, but that they also agree with them in the mode of arrangement.

The minute structure of the teeth in the two so-called genera is very similar. In both, the centre of the tooth is composed of osteo-dentine, having branched anastomosing medullary canals, which are for the most part arranged lengthwise, and give off from their sides rather coarse tubules into the surrounding matter. The canals likewise send off comparatively small branches, which subdivide dichotomously as they approach the periphery of the tooth. Here many of them abut perpendicularly to the surface. The walls of these small branches assume the character of dentine, and the interstices between them are filled up with opaque white matter—probably cement; so that, by the unequal wear of these peripheral components, the surface of the tooth is always kept rough, having the granular and punctate appearance before spoken of. When quite fresh, there is a thin film of enamel covering the surface; but this seems to disappear rapidly with the use of the tooth.

The teeth of both *Climaxodus* and *Janassa* agree with the above general description; but in the latter the material appears more dense, and the cement is in greater abundance and is distributed more regularly than it is in *Climaxodus*; consequently it is found to assume a pretty regular reticulated appearance on the surface when a little worn down.

The generic identity, then, of *Climaxodus* and *Janassa* seems pretty certain; and as the latter was established many years (1832) before the former (1848), the genus *Climaxodus* must merge into that of *Janassa*. Ultimately, perhaps, *Petalodus* will be found to be more closely related than can at present be demonstrated; for it is not only in the Petalodontoid form that a resemblance is observed, but likewise in the primary teeth themselves, which show a remarkable similarity in general form to some of the *Petalodontes*.

Prof. M'Coy seems to think that his *Climaxodus imbricatus* is related to *Pæcilodus*. The relationship, however, with this genus seems to us to be remote, though it may have some characters in common with *Janassa*.

The bodies of these two fishes, *Janassa* and *Climaxodus*, were covered with shagreen. In the former it is beautifully preserved, the granules being highly polished, irregularly rounded, with one side a little flattened and obtusely denticulated. On the small slab, with numerous teeth of *Climaxodus*, already noticed, is a great quantity of granular matter, but the granules are much disturbed; a few, however, are well displayed, and show considerable resemblance to those of *Janassa*; but the denticulations at the side are produced into sharp points, and the surface is undulated.

Although *Climaxodus lingueformis* was pretty fully described in the paper already referred to, we will make, on the present occasion, some general remarks on the teeth in our possession, and also redescribe them.

The species cannot be considered common, though we have obtained eighteen primary teeth in the shale at Newsham and elsewhere, and eight of the secondary or Petalodontoid form. The largest of the former is $1\frac{3}{8}$ inch in length, including the root, and upwards of $\frac{7}{8}$ inch wide at the broadest part. The smaller are not more than $\frac{6}{8}$ inch long, and are oblique: these are the second primary teeth. There are three about this size in the collection. We have one, however, which, from its obliquity, is undoubtedly a lateral tooth, that is only $\frac{3}{8}$ inch in length. They are ovate, depressed, with the broad extremity anterior. The crown is upwards of two-thirds of the entire length, and is divided into two portions, anterior and posterior; the former is a wide, hollow, arched, scoop-like cutting-margin, which in some specimens is obscurely and minutely crenulated or denticulated, and is usually quite sharp: this portion occupies the anterior third of the crown; the posterior two-thirds is shield-formed, somewhat convex, with the point directed backwards and the sides evenly arched outwardly. This is the crushing- or grinding-surface, and is traversed by strong transverse undulated ridges imbricated forward, and divided by wide deep grooves. In fully developed specimens there are six such ridges; but the number varies, some having four, others five; and in the small, second lateral, oblique individuals there are only three. The ridges bend upwards at the sides, and usually arch a little forward at the centre, where they are most strongly undulated and sometimes deeply notched and angulated, roughened and granulated. But they vary considerably in these respects, some being almost smooth; and in one of our specimens all the ridges are comparatively

even, though here and there slight undulations are perceptible. From this comparatively smooth state there is every degree of undulation to the most rugged. In fact, the smoothness is very much owing to wear; and in such specimens this portion of the crown is generally much reduced in thickness. The form of the grinding division of the crown also varies considerably. We have said that the sides arch outwards; they are, however, not unfrequently quite straight; and when this is the case, and the anterior ridge is free from undulations, the area assumes the form of an equilateral triangle, with one of the angles directed backwards; in two or three specimens the area is even wider than long, with the lateral angles more acute than usual. In such individuals the scoop-like cutting-margin occupies half the crown. The root is a wide plate as broad as the tooth, and tapers slightly backwards; behind, it is rounded, convex above and concave below, and projects backwards on a lower plane, the crown being elevated above its upper surface.

The second primary or lateral oblique teeth are very inequilateral, one side being concave, the other convex; they have only three ridges, with the grooves very wide; the scoop-like cutting-margin is deep, oblique, and projects laterally on the concave side.

The largest Petalodontoid or secondary teeth are nearly $\frac{4}{5}$ inch wide and $\frac{3}{8}$ inch long; they are inequilateral and oblique, with one side concave, the other convex; they are depressed, and the crown is somewhat longer than the root; the former consists principally of a wide, sharp, hollow, scoop-like cutting-margin, which in fresh specimens is obscurely denticulated; the grinding-surface is very short, and is represented by only two transverse close-set delicate ridges immediately below the cutting-margin; the root tapers a little backwards, and is truncate.

From the character of the teeth above described, it may be inferred that the food of *Climaxodus* was composed of some soft material, notwithstanding the rather formidable appearance of the grinding- or crushing-surface. The cutting-edge of the scoop-like margin is sharp and thin, and does not seem calculated to seize hard and resistant bodies; and though it is frequently worn evenly down, its sharpness is maintained, often, apparently, by the wearing of the outside, as though the teeth had been overlapped by those that opposed them. And, moreover, the edge is not broken or chipped, as might be expected if it had rough work to perform, or came into contact with bony or shelly bodies. Neither are the ridges of the crushing-surface broken, but worn regularly, retaining their sharpness, though in a few instances they are much reduced

in height, as if they might even ultimately by long use entirely disappear.

At present only three species of *Janassa* are known, namely, *J. bituminosa*, Münster, from the Magnesian Limestone, *Climaxodus imbricatus*, M'Coy, from the Mountain Limestone, and *C. linguæformis*, Atthey, from the Coal-measures. Two species have been described by Mr. T. P. Barkas, under the respective names of *C. ovatus** and *C. vermiformis*†. The first is merely the variety with comparatively smooth ridges; the second is the true *C. linguæformis*, which latter was the name first used. Mr. Barkas's two names must therefore fall into the rank of synonyms‡.

Climaxodus imbricatus is somewhat intermediate between the Magnesian-Limestone species and that from the Coal-measures. The crown is narrower and more elongated than it is in *C. linguæformis*, and the ridges are more delicate, thus approximating to *Janassa bituminosa*. The anterior cutting-margin seems to have been deep; but the extreme border is wanting in M'Coy's figure; the root is also deficient. In the description in the 'British Palæozoic Fossils' the posterior extremity is mistaken for the anterior.

Mr. Howse will shortly publish in the 'Annals' a full description of the oral armature of *Janassa bituminosa* in continuation of this paper. It therefore only remains for us to state that the species will stand thus:—

JANASSA, 1832, Münster.

Climaxodus, 1848, M'Coy.

J. bituminosa, 1817, Schloth., sp.

J. imbricata, 1848, M'Coy, sp.

J. linguæformis, 1868, Atthey, sp.

* Geological Magazine, vol. v. p. 495. † *Ibid.* vol. vi. p. 381.

‡ *C. vermiformis* was not described till 1869. Mr. Atthey's description of *C. linguæformis* and that by Mr. Barkas of *C. ovatus* appeared simultaneously on the 1st of November 1868—the first in the 'Annals of Natural History,' the second in the 'Geological Magazine.' Mr. Atthey's paper, however, was read at the meeting of the Tyneside Naturalists' Field Club on the previous 9th of October (see Nat. Hist. Trans. of Northumberland and Durham, vol. iii. p. 295); so that the priority of *C. linguæformis* is clearly established. And, moreover, Mr. Atthey's specimens had been in his cabinet for many years, and were seen, or might have been seen, by all the palæontologists of the district. Mr. Barkas, indeed, says that he named and described *C. ovatus* in a lecture delivered by him, on the 28th of September, to the Mechanics' Institution of Newcastle-upon-Tyne. But, were this even strictly correct, we apprehend it would be no such publication of the species as to secure priority. Where, however, is the record either naming or describing at this time *C. ovatus*? We have searched for it in vain.

EXPLANATION OF PLATE XII.

- Fig. 1.* Two rows of teeth of *Janassa (C.) linguæformis*, a little over the natural size, arranged in order, the anterior row merely indicated: *a*, central primary tooth; *b*, root; *c*, first lateral primary tooth; *d*, second oblique ditto; *e*, secondary or Petalodontoid form; *f*, root of ditto.
- Fig. 2.* Primary tooth of *J. linguæformis*, smooth variety, slightly enlarged: *a*, scoop-like cutting-margin; *b*, grinding- or crushing-surface.
- Fig. 3.* Primary tooth of the same, a little enlarged; worn variety, intermediate between the smooth variety and those much undulated.
- Fig. 4.* Diagram of profile of primary tooth: *a*, scoop-like cutting-margin; *b*, crushing- or grinding-surface; *c*, root.

XXXVIII.—*Descriptions of five Birds and a Hare from Abyssinia.* By WILLIAM T. BLANFORD, F.G.S., C.M.Z.S.

Hirundo æthiopica, sp. nov.

H. similis H. albigulari, Strickl. (Contrib. to Ornith. 1849, pl. 17), sed conspicue minor et torque pectorali interrupta, guttore pectoreque rufescenti-lavatis.

Long. tota 5·25, al. 4·3, rect. med. 1·55, ext. 2·3, tarsi 0·45, rostr. a fr. 0·3, a rict. 0·5 poll. Angl.

Syn. *Cecropis rufifrons*, auct., ex Abyssinia.

Hirundo albigularis, Strickl. apud Heuglin, Ornithologie N. O. Africa's, p. 113 (nec Strickland, l. c.).

Hab. in Abyssinia septentrionali, et in Nubia (teste Heuglin).

Ruticilla(?) fuscicaudata, sp. nov.

R. supra brunnescenti-fusca, uropygio magis rufescente; remigibus rectricibusque fuscis, vix pallidiore marginatis; macula ante-oculari nigrescente, albido circumdata; mento, gula, abdomineque medio sordide albis, pectore et hypochondriis cinerascens. Rostro pedibusque fuscis.

Long. tota circa 5·5 poll. Angl., al. 2·95, caud. 2·2, tars. 0·9, rostr. a fr. 0·45, a rict. 0·7.

Hab. in Abyssinia septentrionali.

The form of this bird resembles *Ruticilla*, the bill being similar and the tarsi smooth in front; but the sombre plumage rather resembles that of a *Sylvia*. Its nearest allies are *R. (Saxicola) familiaris*, Stephens, and *R. (Erythacus) sinuata*, Schlegel. The tail is somewhat rounded, and the wing is less pointed than in *Ruticilla*.

Phylloscopus habessinicus, sp. nov.

Ph. P. trochili similis, sed supra magis viridescens, subtus isabellinus vix flavescens, cauda longiore.